Ordovician ostracodes from the Komstad Limestone

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The results of a pilot study on late Arenigian ostracodes of Bornholm, Denmark, are reported. The hard thermally altered limestone was disintegrated with sodium hyposulphite, the yielded ostracode material is of satisfactory preservation. The ten identified genera include palaeocopes (*Glossomorphites*, *Aulacopsis*, *Ctenentoma*, *Asteusloffia*, *Euprimites*), eridostracans (*Conchoprimitia*), cytherelliformes (*Unisulcopleura*) and metacopes (*Elliptocyprites*, *Longiscula*, *Microcheilinella* and *"Silenis"*). The studied ostracode assemblage shows resemblance to that of the Central Baltoscandian Confacies Belt.

Key words: Ordovician, Komstad Limestone, ostracodes, Bornholm, Skelbro.

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The Arenigian ostracode fauna of Bornholm has been fairly unknown. Poulsen (1965) reports a fair amount of palaeocopid ostracodes in the Skelbro Limestone. Nielsen (1995) reports numerous ostracode occurrences in the Early Ordovician Komstad Limestone from several localities of Bornholm and Scania, but the taxonomic composition of this material is not discussed in his monograph.

The present paper reports the results of a pilot study on ostracodes of the Komstad Limestone of Bornholm, Denmark. Due to a specific laboratory treatment used in course of investigation, the obtained results are not directly comparable to the former Arenigian ostracode record of adjacent areas, but demonstrate the usefulness of this particular method for the study of carbonate microfossils in the thermally altered limestones of Bornholm and Scania.

Geological and palaeogeographical setting

The area of Bornholm is characterized by a condensed Ordovician succession, which is represented by shales, intercalated with few limestone units. The Komstad Limestone represents the only major limestone intercalation in the shale-dominated sequence of Bornholm (Poulsen 1966). It consists of dark limestones with thin argillaceous seams and is richly fossiliferous. Its stratigraphic position was recently discussed by Nielsen (1995). In terms of trilobite zonation, the Komstad Limestone is referred to the *Megistaspis polyphemus, M. simon*, *M. limbata* and *Asaphus expansus* Zones, corresponding to the Volkhov (B_{II}) and Kunda (B_{III}) stages.

Jaanusson (1976, 1982) placed the Bornholm Island, together with neighbouring Scania, into the offshore zone of the Ordovician palaeobasin, the Scanian Confacies Belt. The opinions concerning the paleobathymetry of this belt, and the Bornholm area in particular, have been somewhat controversial (see Nielsen 1995 for a review). Its position in regard to the photic zone is interpreted differently, although the area seemingly represented one offshore belt in the broad ecological zonation of the Baltoscandian Palaeobasin. In the sedimentation models for the eastern part of the palaeobasin (Nestor & Einasto 1997, Dronov et al. 1998) there is a consensus of opinions that the depth gradient was positioned across the boundaries of the confacies belts in more onshore areas, but the same cannot be ascribed to the offshore areas without caution.

The Skelbro Quarry is one of the few exposures of the Komstad Limestone. In this section, the unit is represented by dark grey limestone with a thickness of 4 m. The limestone is hard and fine-grained, con-

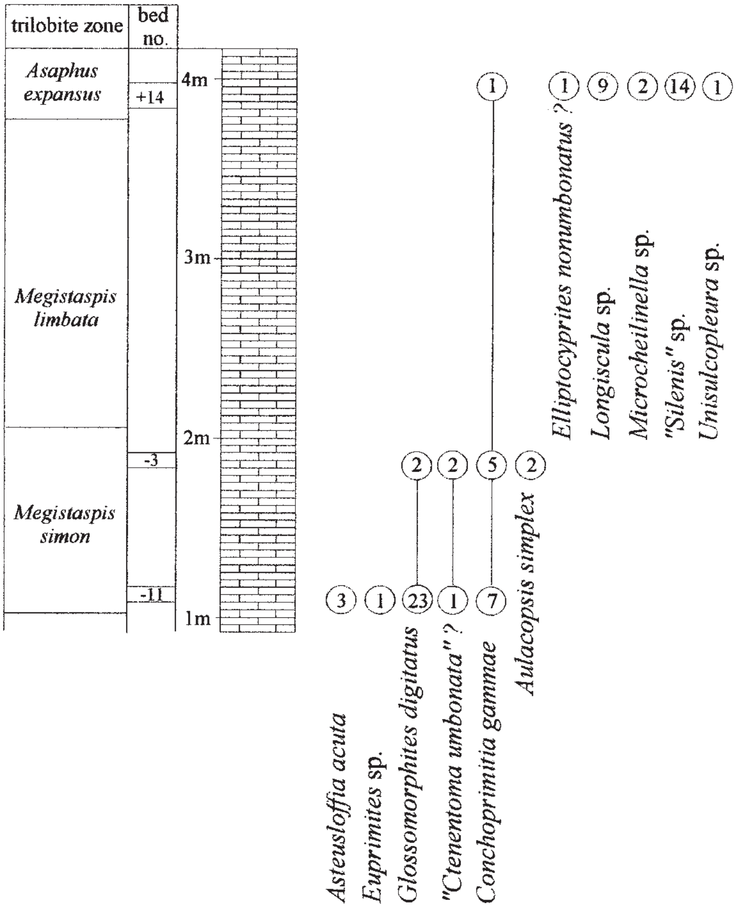


Fig. 1. Distribution of ostracodes in the Skelbro Quarry, Bornholm. Stratigraphy and bed nomenclature after Nielsen (1995, figs 5, 33). Numbers in the circles indicate the number of specimens in the sample.

taining thin argillaceous seams, probably marking the primary bedding plains (see Nielsen 1995, fig. 5, p. 8, for details). The limestone has been thermally altered; the conodont colour alteration index (CAI) reaches 3.5 in Skelbro (Stouge & Rasmussen 1996). The limestone is richly fossiliferous and yields a rich and diverse trilobite fauna, recently described in detail by Nielsen (1995).

Material and methods

In the Skelbro Quarry the rock samples of the Komstad Limestone were taken from the layers -11, -3 and +14 of the nomenclature by Nielsen (1995, Fig. 5). The two lower samples (Fig. 1) are from the *Megistaspis simon* trilobite Zone, corresponding to the middle part of the Volkhov Stage, probably equivalent to the lower part of the Vääna Substage in the East Baltic. The highest sample from layer +14 is from the basal part of the *Asaphus expansus* Zone, corresponding to the lowermost Kunda Stage.

The ostracodes have been extracted by means of the disintegration method described in several papers (Sohn 1961, Schallreuter 1983). The repeated heating and cooling cycles of the dashed material in the presence of a comparable amount of glauber salt or another suitable compound actually provides the results comparable to that of natural weathering process. The satisfactory decay level of clay-rich marls is usually obtained with less than 10 cycles of heating and subsequent cooling up to the complete crystallization of the mixture. On pure limestone varieties the satisfactory results are obtained after several tens of heating cycles. Extremely hard cryptocristalline limestone (“lithographical limestone” by Spjeldnæs & Nitecki 1994) may need over 50 heating cycles for partial destruction, what makes the procedure rather time consuming, but the treatment usually still delivers some material.

A modification of this method is widely used in micropalaeontological labs in Estonia (Meidla 1996a and references therein). The success of this particular method has usually been explained by suitable properties of the carbonate rocks in this area, where the conodont CAI is 1 (Spjeldnæs & Nitecki 1994). In the Ordovician rocks of Scandiavia the conodont CAI is often higher, suggesting a considerable thermal alteration. The disintegration method has mostly been considered as inapplicable in such cases. However, satisfactory results on less altered limestones from Scandinavia have been demonstrated (Meidla 1996b) and this encouraged us to process some test samples of thermally altered limestone. The test samples were taken from Skelbro, Brattefors, Fågelsong, Flagabro, Gårdlösa and Killeröd. All these samples except that of Brattefors yielded a fair amount of ostracodes.

The hard limestone samples were disintegrated by means of sodium hyposulphite as a crystallizing agent. The resistance of the rock material was comparable to that of the hardest unaltered limestone varieties. The washed and dried material was sieved into four fractions (>2mm, 0.5–2mm, 0.25–0.5 mm, <0.25mm). Ostracodes were picked out of the material under the stereoscopic binocular microscope, under the magnification of 16–25×.

Three samples from the Komstad Limestone yielded 74 identifiable ostracode carapaces, valves or larger fragments of satisfactory preservation. Some specimens were preserved as internal molds. The selected specimens were photographed on the scanning electron microscope JEOL (the Centre of Material Research, Tallinn Technical University). Electronic deformation of images, reaching 10% of the height, was corrected digitally with Adobe Photoshop 4.0, using optical measurements of the specimens.

The presence of numerous ostracode valves and carapaces in the Komstad Limestone at Skelbro has been reported by Poulsen (1965) and Nielsen (1995). This material was not studied taxonomically, but the preliminary investigation of the material collected by A. Nielsen (T. Meidla 1994) demonstrated that most of the specimens in this collection are of large size and can be assigned to the genus *Conchoprimitia*, most probably to *Conchoprimitia gammae* Öpik, 1935. The percentage of the members of this genus is remarkably lower in the samples from Bornholm processed by means of the disintegration method. This is probably due to the higher physical resistance of smaller, closed bivalved carapaces to the specific disintegration processes. The hand-splitting of the rock material provides mainly larger, more evenly convex, but unsculptured valves, with the other valves missing or embedded in the rock matrix. Hence results obtained with different preparation methods must be compared with caution.

Species

The Baltoscandian Arenigian ostracode fauna is known to be distinct and endemic. Its relationship to the faunas of Ibero-Armorica and British Isles is documented by Vannier et al. (1989) and this particular study also demonstrates a relatively high diversity of ostracodes of Baltoscandia.

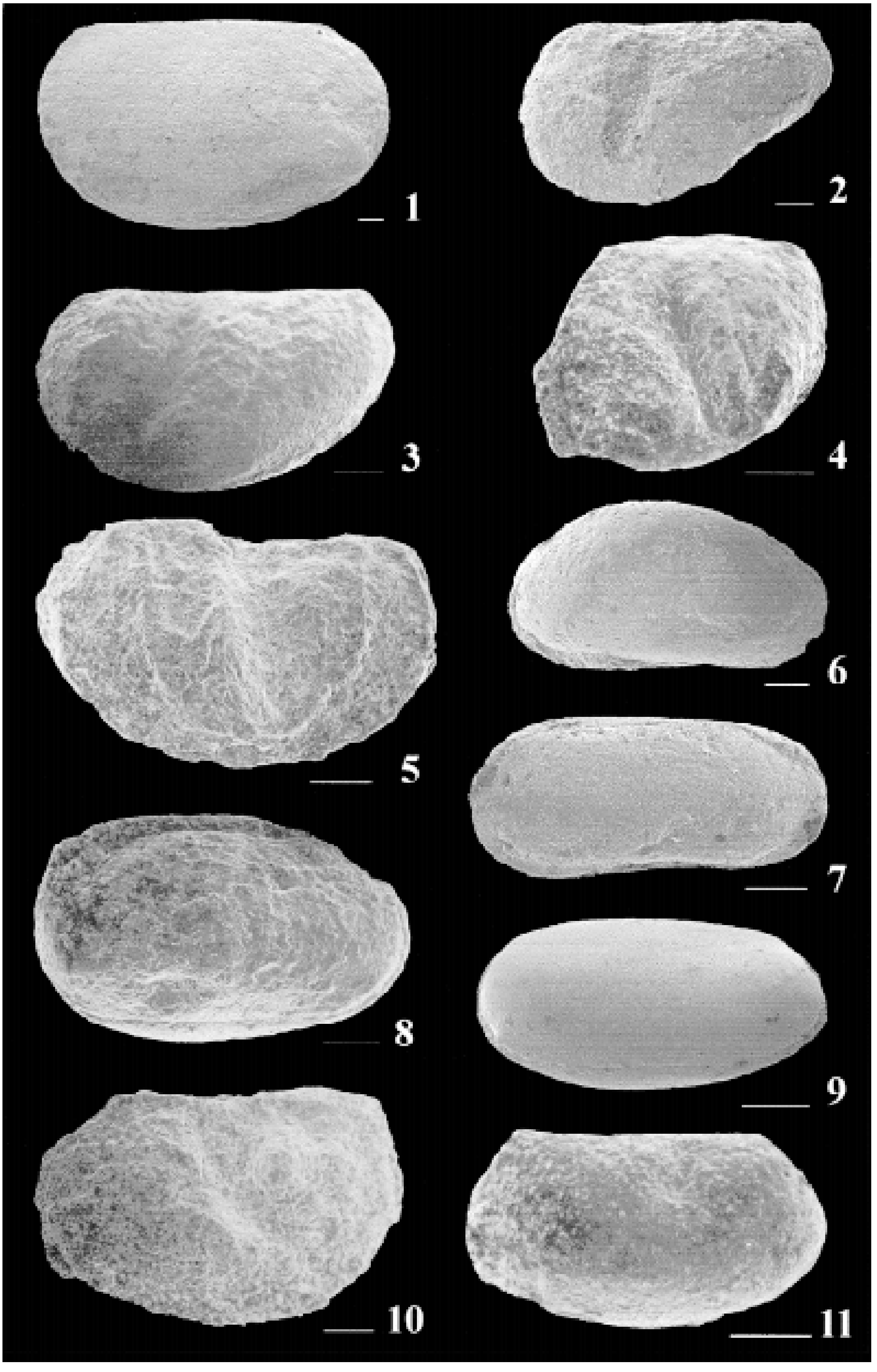
However, the ostracode material extracted from the samples of the Komstad Limestone is comparatively poor. The material was assigned to 11 species, although the scarcity of specimens in some taxa allows identification at the generic level only. The most significant group of the studied fauna are the palaeocopids, with the genera *Glossomorphites* (Pl. 1, figs 3–4), *Aulacopsis* (Pl. 1, fig. 2), *Ctenentoma* (Pl. 1, fig. 10), *Asteusloffia* (Pl. 1, fig. 5) and *Euprimites*. Of the other groups, the eridostracans are represented by *Conchoprimitia* (Pl. 1, fig. 1) and the cytherelliformes by *Unisulcopleura* (Pl. 1, fig. 11). The four metacopid ostracode genera are *Elliptocyprites* (Pl. 1, fig. 9), *Longiscula* (Pl. 1, fig. 6), *Microcheilinella* (Pl. 1, fig. 8) and *"Silenis"* (Pl. 1, fig. 7).

The taxonomic composition of the material in the two lower samples from the beds –11 and –3, from the *Megistaspis simon* trilobite Zone, is fairly similar (Fig. 1). The material comprises mostly the palaeocope genera listed above. The uppermost sample from the level +14 in the *Asaphus expansus* trilobite Zone yielded mainly metacopes. An eridostracan species *Conchoprimitia gammae* Öpik, 1935 (Pl. 1, fig. 1) was found in all sampled levels of the Skelbro Quarry, but in a relatively low number. The find of a single specimen tentatively referred to *Microcheilinella* (Pl. 1, fig. 8) is remarkable, as this genus was known to make its first appearance considerably later, in the middle Viruan of Baltoscandia.

Affinities

The ostracode taxa recognized in the Skelbro Quarry are documented in several bedrock sequences of the East Baltic and Scandinavia. Thorough research has been carried out by Hessland (1949), Henningsmoen (1954), Sarv (1959, 1960, 1963), Gailīte (1982), Sidaravičienė (1992) and Melnikova (1997). Ostracodes in roughly contemporaneous erratic boulders are described by Schallreuter (1988, 1989, 1993, 1994, 1998). Majority of these papers are dealing with the description of new taxa but mostly do not provide detailed faunal logs. More detailed faunal successions are published by Gailīte in Brangulis (1989), Sidaravičienė (1996), Meidla in Põldvere et al. (1998) and Meidla et al. (1998) from the East Baltic area only.

In spite of scarcity of data, the ostracode association in the samples from the Skelbro Quarry bears a very distinctive biofacies affinity. Compared to the reference sections in Estonia, the Volkhovian ostracode assemblage at Skelbro is most similar to the coeval assemblage in the Tartu core (Meidla in Põldvere et al. 1998). This similarity is expressed in the presence of *Aulacopsis* and *Glossomorphites* in both sections, as well as in the absence or scarcity of *Ogmoopsis*,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Tallinnellina and *Brezelina*, widespread and abundant in North Estonia (Sarv 1959, Meidla et al. 1998).

The difference of the particular Tartu/Skelbro association from the North Estonian one is too remarkable for considering it just occasional. It suggests that two distinct ostracode associations existed in the Baltoscandian Palaeobasin during the Volkhov time. Their distribution is not documented in detail yet, but preliminary data suggests some relationship to the broad ecological zonation of the palaeobasin. In terms of confacies zonation, the ostracode assemblage at Skelbro is more similar to that of the Central Baltoscandian Confacies Belt, which was apparently deeper in average than the adjacent North Estonian Confacies Belt.

Conclusions

The ostracode record of the Komstad Limestone in Skelbro Quarry comprises 11 species. The list of common genera of the Skelbro and Tartu sections is considered, as well as the absence or scarcity of the ostracode taxa which prevail in the sections of North Estonia. This suggests the existence of two distinct ostracode associations in the Baltoscandian Palaeobasin at the Volkhov time.

The results also demonstrate that ostracodes can be obtained from hard thermally altered Komstad Limestone by means of the disintegration method, which is mainly considered suitable for unaltered and more delicate rocks only. The obtained ostracode material shows satisfactory level of preservation, but the disintegration method gives different results when compared to the simple splitting of the rock material. The differences may be reflected in the taxonomic composition of different collections as well as in the relative abundance of particular taxa.

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Plate 1. Ostracodes from the Komstad Limestone, Skelbro Quarry.
1. Conchoprimitia gammae Öpik, 1935. Carapace TUG 1041/1, right view. Bed -11, Volkhov Stage. *2. Aulacopsis simplex* (Krause, 1892). Carapace TUG 1041/2, left view. Bed -3, Volkhov Stage. *3. Glossomorphites digitatus* (Krause, 1889). Carapace TUG 1041/3, left view. Bed -11, Volkhov Stage. *4. Glossomorphites digitatus* (Krause, 1889). Posteriorly incomplete carapace TUG 1041/4, right view. Bed -11, Volkhov Stage. *5. Asteusloffia acuta* (Krause, 1891). Right valve TUG 1041/5, lateral view. Bed -11, Volkhov Stage. *6. Longiscula* sp. Carapace TUG 1041/6, right view. Bed +14, Kunda Stage. *7.* "*Silenis*" sp. Carapace TUG 1041/7, right view. Bed +14 Kunda Stage. *8. Microcheilinella* sp. Carapace TUG 1041/8, right view. Bed +14, Kunda Stage. *9. Elliptocyprites nonumbonatus?* (Hessland, 1949). Carapace TUG 1041/9, right view. Bed +14, Kunda Stage. *10. Ctenentoma* cf. *umbonata* (Steusloff, 1895). Right valve TUG 1041/10, lateral view. Bed -3, Volkhov Stage. *11. Unisulcopleura* sp. Right valve TUG 1041/11, lateral view. Bed +14, Kunda Stage.
The scale equals 0.1 mm.

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Dansk sammendrag

I artiklen beskrives resultaterne af et pilotstudie af ostrakodfaunaen i den nedre ordoviciske Komstad Kalk på Bornholm. Studiet viste, at det er muligt at nedbryde den hårde kalksten ved fryse/tø metoden og udvinde et rimeligt bevaret materiale af ostrakoder. Faunaens sammensætning, der indeholder mere end 10 bestembare slægter, kan bedst sammenlignes med ostrakodfaunaerne i det centrale baltoskandiske facies bælte (rød 'Orthoceratitkalk').

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